September 8, 2010
NIEHS Keystone Campus, Room 1003AB, Durham NC 27709

The meeting will be webcast at http://www.niehs.nih.gov/news/video/live/

Agenda

8:30-8:45	*Welcome and introductions*	Linda Birnbaum and Geri Dawson
8:45-9:00	*Charge to group*	Cindy Lawler
9:00-10:00	*Lessons learned from other environmentally-mediated disorders*	**Discussion Leader: Cindy Lawler & Alycia Halladay** Jason Richardson, Caroline Tanner, Kim McAllister
10:00-10:15	*Break*	
10:15-11:15	*Novel tools and approaches in toxicology and genomics*	**Discussion Leader: Isaac Pessah** Ray Tice, Carolyn Mattingly, Thomas Knudsen, David Armstrong, Steven Scherer, Aaron Bowman
11:15-12:45	*Cellular and molecular mechanisms*	**Discussion Leader: Isaac Pessah** Jean Harry, Lisa Boulanger, Serena Dudek, Patricia Jensen, Glen Rall
12:45-1:15	*Working lunch*	
1:15-2:45	*Epidemiology and exposure science*	**Discussion Leader: Lisa Croen** Geri Dawson, Dani Fallin, Dana Barr, Igor Burstyn
2:45-3:00	*Break*	
3:00-4:15	*General discussion and summary of recommendations*	**Discussion Leader: Geri Dawson & all subgroup leaders**
4:15-4:30	*Wrap up and next steps*	Cindy Lawler

This meeting is being sponsored by the National Institute of Environmental Health Sciences (NIEHS) in partnership with Autism Speaks.

September 8, 2010
NIEHS Keystone Campus
Room 1003AB, Durham NC 27709

The meeting will be webcast at http://www.niehs.nih.gov/news/video/live/

Workshop goal:

The goal of this workshop is to identify novel opportunities and mechanisms to accelerate research on environmental factors and autism, guided by (1) recent advances in autism research; (2) emerging tools and technologies in environmental health sciences and (3) analogy to successful approaches in other environmentally-mediated diseases. This workshop represents a joint effort between the National Institute of Environmental Health Sciences (NIEHS) and Autism Speaks.

Workshop products:

The products of this workshop will include recommendations for (1) highest priority areas of research that address the contribution of environmental factors for risk and phenotypic expression of autism; (2) possible solutions for any barriers to progress identified in these areas; and (3) other resources needed for increasing the pace of this research. The workshop products will be shared with the Interagency Autism Coordinating Committee (IACC) and may be considered in the ongoing process for evaluating and refining the IACC Strategic Plan.

Primary topics for discussion

Topic 1: Lessons learned from other environmentally-mediated disorders. (Cindy Lawler, Jason Richardson, Caroline Tanner, Alycia Halladay, Kim McAllister)

- What are the lessons learned from other disorders that demonstrate how information about known risks from single genes or gene pathways can provide clues for environmental etiologies?
- What are the most successful examples of interdisciplinary integration of basic and clinical research in other environmentally mediated diseases (e.g., Parkinson's disease, asthma) that could provide a model for cross fertilization?
- What is needed to shift the current paradigm of waiting for autism epidemiology studies to provide clues to pursue in basic mechanistic studies?

Topic 2: New tools, technologies and approaches in toxicology and genomics. (Isaac Pessah, Raymond Tice, Thomas Knudsen, Carolyn Mattingly, Aaron Bowman).

- How can new tools and approaches being developed in toxicology and genomics be used to advance research in environment and autism? Areas to consider include but are not limited to
    - bioinformatics and computational approaches to discern relationships among genes and to identify potential interactions of genes and toxicants (e.g., Comparative Toxicogenomics Database).
    - novel sequencing tools and other genomic approaches, including tools to measure epigenetic modifications and structural variation (e.g., copy number variation)
    - induced pluripotent stem cells to study developmental vulnerability to toxicants
    - mechanistically-based high throughput screening approaches for neurotoxicology endpoints relevant to autism
- What are the primary obstacles to application of these tools to address environmental influences in autism and how can these obstacles be overcome?

Topic 3: Cellular, molecular and organismic mechanisms and models. (Isaac Pessah, Jean Harry, Serena Dudek, Sheryl Moy, Lisa Boulanger, Patricia Jensen, Glenn Rall)

- How can advances in autism science inform mechanistic investigations of environmental inputs to autism? For example, do recent genetic or immune findings suggest specific molecular targets or pathways that could help prioritize candidate exposures or provide tractable models for pursuing the impact of exposures on autism risk?
- What models (e.g., whole animal, cellular) are currently available and relevant to autism pathobiology? What are the barriers to progress in development, dissemination and use of these models?

Topic 4: Exposure Science and epidemiology approaches. (Lisa Croen, Dana Barr, Danielle Fallin, Igor Burstyn, Geri Dawson)

- How can we harness improvements in exposure metrics to identify environmental etiologies of autism? This could include discussion of a range of approaches being developed, from GIS-based models to biomarkers and personal sensors and consideration of emerging toxicants.
- What study design and analytic approaches are best suited for understanding the joint effects of genes and environment in epidemiology studies? For example, how can exposure information be combined with the large amounts of genetic data that is now available in autism?

- Are there unique opportunities and populations internationally for studying association of exposures with autism? For example, how can we capitalize on recent improvements in international infrastructure/capacity for autism surveillance?
- What are the primary obstacles to progress for autism epidemiology?

Participant List

David Armstrong, Ph.D.
Principal Investigator and Chief, Laboratory of Neurobiology
National Institute of Environmental Health Sciences, NIH
111 TW Alexander Drive. MD F2-05
Research Triangle Park, North Carolina 27709

Dana Boyd Barr, Ph.D.
Environmental and Occupational Health
Rollins School of Public Health
1518 Clifton Road, NE, Room 272
Atlanta, GA 30322

Linda S. Birnbaum, Ph.D., D.A.B.T., A.T.S
Director,
National Institute of Environmental Health Sciences and National Toxicology Program
111 TW Alexander Drive. MD B2-01
Research Triangle Park, North Carolina 27709

Lisa Boulanger, Ph.D.
Assistant Professor of Molecular Biology/Princeton Neuroscience Institute,
Princeton University
Washington Road, LTL 123
Princeton, NJ 08544-1014

Aaron Bowman, Ph.D.
Assistant Professor of Neurology
Vanderbilt University
465 21st Avenue South, 6110C MRBIII
Nashville, TN 37232-8552

Igor Burstyn, Ph.D.
Associate Professor, Department of Environmental and Occupational Health
Drexel University School of Public Health
1505 Race Street, 13th floor
Philadelphia, Pennsylvania, 19102

Gwen Collman, Ph.D.
Interim Director
Division of Extramural Research and Training
National Institute of Environmental Health Sciences
Keystone Building, MD K3-01
530 Davis Drive
Durham, NC 27713

Lisa Croen, Ph.D.
Senior Research Scientist
Director, Autism Research Program
Kaiser Permanente Division of Research
2000 Broadway
Oakland, CA 94612

Geraldine Dawson, Ph.D.
Chief Science Officer, Autism Speaks
Research Professor, Department of Psychiatry
UNC Chapel Hill
4120 Bioinformatics Building
130 Mason Farm Road, Campus Box 3366
University of North Carolina |Chapel Hill, NC 27599-3366

Serena M. Dudek, Ph.D.
Laboratory of Neurobiology
National Institute of Environmental Health Sciences, NIH
111 TW Alexander Drive. MD F2-04
Research Triangle Park, NC 27709

M. Danielle Fallin, Ph.D.
Epidemiology, Genetic Epidemiology, Biostatistics, and Medicine, Johns Hopkins University
Departmental Address:
615 N. Wolfe St., Room W6509
Baltimore, MD 21205

Alycia Halladay, Ph.D.
Director of Research for Environmental Sciences
Autism Speaks
2 Park Ave, 4th Floor
New York, NY 10016

Gaylia Jean Harry, Ph.D.
Laboratory of Toxicology and Pharmacology
National Institute of Environmental Health, NIH
111 T.W. Alexander Drive. MD C1-04
Research Triangle Park, NC 27709

Patricia Jensen, Ph.D.
Developmental Neurobiology Group
Laboratory of Neurobiology
National Institute of Environmental Health Sciences, NIH
111 TW Alexander Drive. MD F2-10
Research Triangle Park, NC 27709

Thomas B. Knudsen
National Center for Computational Toxicology, Office of Research and Development, U S Environmental Protection Agency, Research Triangle Park, NC 27711

Cindy P. Lawler, Ph.D.
Program Director
Cellular, Organ, Systems and Pathobiology Branch
Division of Extramural Research and Training
National Institute of Environmental Health Sciences
Keystone Building, MD K3-15
530 Davis Drive
Durham, NC 27713

Carolyn Mattingly, Ph.D.
Investigator and Director of Bioinformatics Core, Mount Desert Biological Lab, University of Maine
Mount Desert Biological Lab
Old Bar Harbor Road
PO Box 35
Salisbury Cove, Maine 04672

Kimberly A. McAllister, Ph.D.
Program Director
Susceptibility and Population Health Branch
Division of Extramural Research and Training
National Institute of Environmental Health Sciences
Keystone Building, MD K3-12
530 Davis Drive
Durham, NC 27713

Sheryl Moy, Ph.D.
Associate Professor, Department of Psychiatry at UNC-Chapel Hill;
Director, Mouse Behavioral Phenotyping Laboratory,
Carolina Institute for Developmental Disabilities (CIDD)
CB#7146
University of North Carolina
Chapel Hill, NC 27599, USA.

Isacc Pessah, Ph.D.
Professor and Chair, Department of Molecular Biosciences, School of Veterinary Medicine;
Director, UC Davis Children's Center for Environmental Health and Disease Prevention
University of California, Davis Department of Molecular Biosciences, Haring Hall
1278 Surge III
Davis, CA 95616

Glenn Rall, Ph.D.
Associate Professor,
Fox Chase Cancer Center
333 Cottman Avenue
Philadelphia, PA 19111-2497

Lyn Redwood, R.N., M.S.N.
Co-Founder and Vice President
Coalition for SafeMinds
Tyrone, GA 30290

Jason Richardson, M.S. Ph.D.
Assistant Professor, Department of Environmental and Occupational Medicine at Robert Wood Johnson Medical School; Resident Member of the Environmental and Occupational Health Sciences Institute
170 Frelinghuysen Road
EOHSI 340
Piscataway, NJ 08854

Stephen W. Scherer, Ph.D.
Director, The Centre for Applied Genomics and McLaughlin Centre, University of Toronto;
Senior Scientist, The Hospital for Sick Children;
Professor of Medicine, University of Toronto
14th Floor, Toronto Medical Discovery Tower/MaRS Discovery District
101 College St.
Toronto, Ontario, M5G 1L7, Canada

Caroline M. Tanner, M.D. Ph.D.
Director of Clinical Research, Parkinson's Institute
675 Almanor Ave.
Sunnyvale, CA 94085

Raymond Tice, Ph.D.
Chief, Biomolecular Screening Branch
National Institute of Environmental Health Sciences and National Toxicology Program
111 T. W. Alexander Drive. MD K2-17
Durham, NC 27713

Contributors' Biographies

David Armstrong
Principal Investigator and Chief, Laboratory of Neurobiology, Membrane Signaling Group, National Institute of Environmental Health Sciences

David L. Armstrong, Ph.D., is the Chief of the Laboratory of Neurobiology in the Division of Intramural Research at NIEHS. He was trained as an electrophysiologist at Caltech (PhD 1979) and carried out postdoctoral work at University College London and the Salk Institute on the developmental role of innervation on embryonic skeletal muscle coupling through gap junctions. His research group at NIEHS studies the molecular mechanisms of ion channel regulation, which have led to new insights into the signaling of thyroid hormone receptors and the Rac GTPase, which are essential for the normal development of the brain. They have also shown how single nucleotide polymorphisms in ion channel genes increase susceptibility to disease by introducing new phosphorylation sites and altering channel regulation. Several of these channels and signaling proteins have been reported to show genetic changes associated with autism and are the targets of numerous microbial toxins and industrial xenobiotics.

Dana Boyd Barr
Environmental and Occupational Health, Rollins School of Public Health, Emory University

After a 22-year career with the Centers for Disease Control and Prevention, Dana Barr has embarked on a new endeavor in academia. She joined the faculty at Emory's Rollins School of Public Health in 2010 where she plans on developing an analytical core in the Department of Environmental and Occupational Health to assist Emory and external researchers in exposure assessment, but also plans to pursue her own research that includes better understanding of biomarkers and developing a framework for their interpretation. She is interested in how environmental exposures relate to neurodegenerative disease and also the effects that climate change will have on our environmental exposures and how new manufacturing practices (including nanotechnology and green chemistry) affect our exposures.

Linda S. Birnbaum
Director, National Institute of Environmental Health Sciences and National Toxicology Program

Linda S. Birnbaum is Director of the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH), and the National Toxicology Program. As NIEHS and NTP director, Dr. Birnbaum oversees a budget that funds multidisciplinary biomedical research programs, prevention, and intervention efforts that encompass training, education, technology transfer, and community outreach. The NIEHS supports more than 1,000 research grants.

Dr. Birnbaum has received numerous awards, including the Women in Toxicology Elsevier Mentoring Award, the Society of Toxicology Public Communications Award, EPA's Health Science Achievement Award and Diversity Leadership Award, and 12 Science and Technology Achievement Awards. She is the author of several hundred peer-reviewed publications, book chapters, abstracts, and reports. Dr. Birnbaum received her M.S. and Ph.D. in microbiology from the University of Illinois, Urbana. A board certified toxicologist, Dr. Birnbaum has served as a federal scientist for 30 years - 19 years with the U.S. Environmental Protection Agency Office of Research and Development, and the first ten years at NIEHS as a senior staff fellow at the National Toxicology Program, then as a principal investigator and research microbiologist, and finally as a group leader for the Institute's Chemical Disposition Group.

Lisa M Boulanger
Assistant Professor of Molecular Biology / Princeton Neuroscience Institute, Princeton University

Dr. Boulanger came to the Princeton faculty from the University of California-San Diego, where she was a faculty member since 2004 and where she earned her Ph.D. Previously she was a member of the Harvard Society of Fellows and a postdoctoral associate at the University of California-Berkeley. A specialist in molecular mechanisms of circuit formation and modification in the mammalian brain, Boulanger holds a bachelor's degree from Boston University and a master's degree from Wesleyan University. Her current research focuses on the role of immune molecules in the establishment, maintenance, modification, and disruption of brain structure and function.

Aaron Bowman
Assistant Professor of Neurology, Vanderbilt University

Dr. Bowman graduated from the University of California San Diego with a Ph.D. in Biomedical Sciences in 2000, and was a Lucille P. Markey Fellow in Biomedical Sciences. He began his postdoctoral studies at Princeton University, were he was awarded a Life Sciences Research Foundation Postdoctoral Fellowship. In 2003, Dr. Bowman continued his studies at Baylor College of Medicine where he was awarded a Hereditary Disease Foundation Postdoctoral Fellowship. Dr. Bowman joined the faculty at Vanderbilt University Medical Center in 2006 as an Assistant Professor for the Department of Neurology. He is also an Investigator of the Vanderbilt Kennedy Center for Research on Human Development. His laboratory employs a diverse range of model systems, including patient-derived induced pluripotent stem cells (iPSCs), neuronal culture, and mouse models to understand interactions between human neurodegenerative disease genes and environmental factors that underlie selective neuropathology.

Igor Burstyn
Associate Professor, Department of Environmental and Occupational Health

Dr. Igor Burstyn is an accomplished educator and researcher in the field of environmental and occupational health, with training in both epidemiology and occupational hygiene. His research primarily focuses on the identification of sources and the health impacts of occupational and environmental

exposures, with particular interest in the effect of environmental *in utero* exposures on health of pregnant women and their children. He collaborates extensively, both nationally and internationally.

In addition to his position as an associate professor at the Drexel University School of Public Health, Dr. Burstyn also serves as an adjunct professor at the Department of Medicine and Institute for Risk Assessment Sciences at Utrecht University in the Netherlands. Prior to joining Drexel University, he served as an associate professor with the Department of Medicine at the University of Alberta.

Dr. Burstyn has published extensively in the areas of occupational hygiene and exposure assessment, as well as occupational and environmental epidemiology, and has presented his research at numerous conferences. He is the PI on a record-linkage study of ASD among children born in Alberta, Canada with the first paper in press (**Burstyn I**, Sithole F, Zwaigenbaum L: Autism spectrum disorders, maternal characteristics and obstetric complications among singletons born in Alberta, Canada. *Chronic Diseases in Canada* 30(4): (2010)) and contributes his environmental health expertise to EARLI.

Dr. Burstyn has taught graduate courses in occupational hygiene and epidemiology. He has also served as an advisor for both master's (MSc and MPH) and doctoral students, and successfully mentored a number of post-doctoral fellows.

Dr. Burstyn received his PhD in Environmental and Occupational Health from Utrecht University in the Netherlands, his Master of Science degree in Occupational Hygiene from the University of British Columbia, and his Bachelor of Science degree in Microbiology from the University of British Columbia.

Gwen Collman
Interim Director, Division of Extramural Research and Training, National Institute of Environmental Health Sciences

Gwen Collman is the Acting Director of the Division of Extramural Research and Training. She has been involved the creation and implementation of many multidisciplinary research programs in areas such as Children's Environmental Health, Breast Cancer and the Environment, Partnerships in Environmental Public Health and the Genes, Environment and Health Initiative's Exposure Biology Program. Gwen has been active in expanding the NIEHS' extramural research program in environmental and genetic epidemiology, translation from basic environmental health science to public health and to increase our pool of junior investigators in all areas of environmental health research.

Lisa Croen
Senior Research Scientist; Director, Autism Research Program, Kaiser Permanente Division of Research

Dr. Croen is a perinatal epidemiologist. Her research interests include the epidemiology of Autism and other neurodevelopmental disorders, environmental exposures and gene/environment interaction, and adverse perinatal outcomes. She is the PI of the Early Markers for Autism (EMA) Study, an investigation of prenatal and neonatal biologic markers for Autism, funded by the National Institutes of Health. She is also the site PI on two large federally funded Autism Spectrum Disorder studies. The first is the Study to

Explore Early Development (SEED), a large, national case-control study focused on environmental and genetic risks for Autism Spectrum Disorders, funded by the Centers for Disease Control and Prevention. The second is the Early Autism Risks Longitudinal Investigation (EARLI) study, a prospective longitudinal cohort study of risk factors for autism in growing families, funded by the National Institutes of Health. She is also Co-Investigator on the California Autism Twins Study (CATS), funded by the National Institute of Mental Health. Dr. Croen's research interests also include health service delivery for individuals with autism, and in collaboration with clinical colleagues, she directs the Kaiser Permanente site of the Autism Treatment Network and Autism Intervention Research program, funded by Autism Speaks and HRSA.

Geraldine Dawson
Chief Science Officer, Autism Speaks; Research Professor of Psychiatry, University of North Carolina at Chapel Hill

Dr. Dawson is the chief science officer for Autism Speaks, where she works with the scientific community and other stakeholders to shape and expand the organization's scientific vision. Dr. Dawson holds the positions of Research Professor of Psychiatry at the University of North Carolina at Chapel Hill, Adjunct Professor of Psychiatry at Columbia University, and Professor Emeritus of Psychology at University of Washington. Dawson is a licensed clinical psychologist who has published extensively on autism spectrum disorders, focusing on early detection and intervention and early patterns of brain dysfunction. In collaboration with Dr. Sally Rogers, Dawson helped to develop and empirically-validated the *Early Start Denver Model*, the first comprehensive early intervention program for toddlers with autism. She has collaborated on numerous studies of brain development and function and genetic risk factors in autism. From 1996-2008, Dawson was Founding Director of the University of Washington Autism Center where she directed three NIH Autism Center of Excellence Award programs of research focusing on genetics, neuroimaging, early diagnosis, and clinical trials. At the Center, she also oversaw multi-disciplinary diagnostic and treatment services for children with autism from infancy through late adolescence. Dawson has been a consultant to the National Institutes of Health since 1989, including participating on the NIH Committee on Practice Parameters for Screening and Diagnosis of Autism, NIH Scientific Advisory Panel to establish a 10 year road map for autism research, the NIH Consensus Panel on Phenylketonuria, and three NIH Grant Review Committees. Dawson is a Fellow of the American Psychological Society, American Psychological Association, and the Society of Clinical Child and Adolescent Psychology. Dawson's honors include the Autism Society of America Award for Valuable Service, Washington Autism Society Achievement Award for Outstanding Service, Autism Society of Washington Medical Professional of the Year, Autism Society of America Award for Research Contributions, and the Autism Hero Award from Cure Autism Now. Dr. Dawson received her Ph.D. in Developmental and Child Clinical Psychology from the University of Washington.

Serena Dudek
Principal Investigator, Laboratory of Neurobiology, Developmental and Synaptic Plasticity Group, National Institute of Environmental Health Sciences

Dr. Dudek heads the Synaptic and Developmental Plasticity Group in the Laboratory of Neurobiology in the Division of Intramural Research at NIEHS. She began working in the area synaptic plasticity while an undergraduate student at the University of California at Irvine. She received her Ph.D. from Brown University (1992), where she discovered NMDA receptor dependent long-term synaptic depression (LTD) in the hippocampus. Following postdoctoral work at the University of Alabama at Birmingham and at the NICHD, Dr. Dudek moved to NIEHS where her laboratory studies the cellular mechanisms of synaptic plasticity in the adult and developing mammalian cortex. Her group was the first to image cortical synapse pruning in real time and they are currently investigating the underlying molecular processes. They have also demonstrated that synaptic plasticity is regulated differently in one area of the brain that has been implicated in social behaviors, hippocampal area CA2. Thus genetic and environmental factors that interfere with synaptic plasticity and normal synapse pruning during development can have life-long consequences on cognitive abilities. Dr. Dudek edited the book, "Transcriptional Regulation by Neuronal Activity", is a member of the Programming Committee of the Society for Neuroscience, and is the recipient of the 2009 A. E. Bennett Research Award from the Society of Biological Psychiatry.

M. Daniele Fallin
Epidemiology, Genetic Epidemiology, Biostatistics, and Medicine, Johns Hopkins University

Dr. Fallin is the Principal Investigator for the Maryland Early Autism Risk Longitudinal Investigation (EARLI) site at the Johns Hopkins School of Public Health. She is an experienced genetic epidemiologist who heads the Genetic Epidemiology division of the Department of Epidemiology at Johns Hopkins. She has expertise in complex statistical genetics methods as well as in overseeing and directing fieldwork for epidemiologic and genetic studies of neuropsychiatric conditions including autism, schizophrenia, and Alzheimer's disease. She is also the Maryland PI for the Study to Explore Early Development (SEED), a multi-site case-cohort study to identify genetic and environmental risk factors for autism, funded by the CDC. In addition to these two large autism studies, Dr. Fallin oversees the Genetic Epidemiology aspects of the JHU Center for Excellence in Genome Sciences (CEGS) focused on Epigenetics of Common Disease. The CEGS is investigating the epigenetic mechanisms of autism and schizophrenia and the interactions of genes and environment with epigenetics.

Alycia Halladay
Director of Research for Environmental Sciences, Autism Speaks
Alycia Halladay is Director of Research for Environmental Sciences at Autism Speaks, managing the environmental sciences research portfolio including initiatives, feasibility studies and peer-reviewed grant funding. She works with other members of the etiology research team to identify research and scientific opportunities in environmental sciences, gene x environment interactions and epidemiology. In addition to the environmental sciences portfolio, Alycia oversees some of the diagnosis and phenotyping portfolios, including the high risk infant siblings consortium and the toddler treatment network. Prior to joining Autism Speaks in 2005, Alycia received a PhD in behavioral neuroscience and

completed a post-doctoral fellowship in pharmacology and toxicology from Rutgers University, focusing on toxicant exposure and animal models of autism spectrum disorders. While an assistant research professor, she worked on research projects involving heavy metals and gene expression, behavioral toxicology, behavioral pharmacology and molecular toxicology. She also holds an adjunct faculty position at Rutgers University.

Gaylia Jean Harry
Laboratory of Toxicology and Pharmacology, National Institute of Environmental Health Sciences

Dr. Jean Harry is Head of the Neurotoxicology Group in the Laboratory of Toxicology and Pharmacology at the NIEHS, serves as the Neurotoxicology Discipline Leader for the National Toxicology Program and has adjunct appointments in the Toxicology Programs of both University of North Carolina/Chapel Hill and Duke University. She received her Ph.D. in neuropharmacology/psychology from Virginia Commonwealth University and additional training in neuropathology and neurochemistry of developmental neurotoxicant exposure at the University of North Carolina. She has been actively involved in research on developmental neurotoxicology, neuroimmunology, and regulation of injury-induced neurogenesis. Her current research focuses on the interaction between resident immune cells of the brain and the regulation of neural progenitor cells following chemical exposure. She has served on numerous national and international committees and working groups with reference to neurotoxicology including the World Health Organization, USEPA, International Life Sciences Institute.

Patricia Jensen
Developmental Neurobiology Group, Laboratory of Neurobiology, National Institute of Environmental Health Sciences

Patricia Jensen, Ph.D., is the Head of the Developmental Neurobiology Group in the Division of Intramural Research at NIEHS. She trained as a neuroscientist at the University of Tennessee Neuroscience Center. Her graduate studies in the laboratory of Dr. Dan Goldowitz focused on the cellular and molecular interactions underlying cerebellar morphogenesis. During her postdoctoral training in the laboratory of Dr. Tom Curran at St. Jude Children's Research Hospital she managed the high-throughput in situ hybridization screen as part of the GENSAT project. In 2005 she joined the laboratory of Dr. Susan Dymecki at Harvard Medical School as a postdoctoral fellow where she carried out molecular and genetic studies focusing on the embryonic and molecular development of individual serotonergic (5-HT) neuron subtypes. She is currently investigating how genetic and environmental perturbations during development alter the fates and functions of central noradrenergic neuron subtypes.

Thomas B. Knudsen
Developmental Systems Biologist, NCCT, US Environmental Protection Agency

Dr. Tom Knudsen is a Developmental Systems Biologist at the US Environmental Protection Agency's National Center for Computational Toxicology. He received his Ph.D. in Anatomy from Thomas Jefferson University and postdoctoral training at the Children's Hospital Research Foundation in Cincinnati and Emory University. Before joining EPA, he was Professor at the University of Louisville. Dr. Knudsen's research is focused on predictive models of developmental toxicity, using high-throughput screening data, multicellular models and computational systems biology. In addition to his research at EPA, Dr. Knudsen is Adjunct Professor at the University of Louisville, Editor in Chief of *Reproductive Toxicology* and Past-President of the Teratology Society.

Cindy P. Lawler
Program Director, Division of Extramural Research and Training, National Institute of Environmental Health Sciences

Cindy Lawler, PhD is a Program Director in the Division of Extramural Research and Training at the National Institute for Environmental Health Sciences, one of the National Institutes of Health. Dr. Lawler is the NIEHS representative for extramural autism activities; this includes responsibilities as a program official for the NIH-funded Early Autism Risk Longitudinal Investigation (EARLI) study. In addition to her programmatic role in autism activities, Dr. Lawler has lead responsibility for management of the NIEHS extramural portfolio of research in Parkinson's disease research. Prior to joining NIEHS, Dr. Lawler was a faculty member in the Department of Psychiatry and the Brain and Development Research Center at the University of North Carolina at Chapel Hill, where she conducted research in behavioral neuroscience, with an emphasis on dopamine receptor pharmacology. Dr. Lawler received her Ph.D. in Experimental Psychology from Northeastern University in 1987.

Carolyn Mattingly
Investigator and Director of Bioinformatics Core, Mount Desert Biological Lab, University of Maine

Dr. Mattingly's research program focuses on understanding the effects of environmental chemicals on development and human health. This program comprises bioinformatics and experimental approaches. The former involves development of the publicly available Comparative Toxicogenomics Database (CTD; http://ctd.mdibl.org), which provides integrated data about chemical-gene/protein interactions and chemical- and gene-disease relationships, thus enabling scientists to develop novel hypotheses about the origins of environmentally influenced diseases. The experimental approach uses zebrafish (*Danio rerio*) as a vertebrate model to elucidate the molecular mechanisms underlying craniofacial abnormalities that result from developmental exposure to the ubiquitous environmental contaminant, 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD - the most toxic form of dioxin.

Kimberly McAllister
Program Director, Division of Extramural Research and Training, National Institute of Environmental Health Sciences

Kimberly McAllister, Ph.D., received a B.S. in Honors Biology at the University of Illinois and a Ph.D. in Human Genetics from the University of Michigan. She cloned and identified a human disease gene for Hereditary Hemorrhagic Telangiectasia for her Ph.D. dissertation. Afterward, she worked in the intramural division of the National Institute of Environmental Health Sciences (NIEHS) for eight years where her projects focused on developing an appropriate mouse model for breast cancer by inactivating the Brca2 (Breast Cancer Susceptibility) gene in mice using both a germline and conditional knockout approach. Dr. McAllister is currently a program administrator in the extramural division of NIEHS, in the Susceptibility and Population Health Branch, where she has managed and developed an expanding genetic epidemiology, human genetics, G x E methods, basic genetics, DNA repair, and animal model/comparative biology portfolio.

Sheryl S. Moy
Associate Professor, Department of Psychiatry at UNC-Chapel Hill; Director, Mouse Behavioral Phenotyping Laboratory, Carolina Institute for Developmental Disabilities (CIDD)

Dr. Moy is an Associate Professor in the Department of Psychiatry at UNC, and serves as Director of the Mouse Behavioral Phenotyping Laboratory, a core facility of the Carolina Institute for Developmental Disabilities (CIDD). Dr. Moy holds a doctorate in Experimental and Biological Psychology, with a focus on behavioral pharmacology, and she completed a postdoctoral fellowship in the Brain and Development Research Center at UNC. Her area of expertise is the development and testing of rodent models for human clinical syndromes, including models for autism, schizophrenia, and other neurodevelopmental disorders. Current efforts include the behavioral, pharmacological, and neuroanatomical characterization of mouse models for repetitive behavior and restricted interests observed in autism spectrum disorders, and neonatal behavioral evaluations in a mouse model of NMDA receptor hypofunction, relevant to schizophrenia. In addition, Dr. Moy has served as an investigator or collaborator on multiple projects from CIDD investigators, including studies focused on gene x environment interactions and preclinical efficacy testing with novel therapeutic agents.

Isaac N. Pessah
Professor and Chair, Department of Molecular Biosciences, School of Veterinary Medicine; Director, UC Davis Children's Center for Environmental Health and Disease Prevention

Dr. Pessah is a toxicologist with research interests in the area of molecular and cellular mechanisms regulating signaling in excitable cells. His current research focuses on the structure, function, and pharmacology of the ryanodine-sensitive calcium channels (RyRs) found in sarcoplasmic and endoplasmic reticulum of muscle cells and neurons. His laboratory is actively studying how dysfunction of RyR complexes contribute to genetic diseases and how genetic alteration of RyRs and environmental factors interact to influence neurodevelopment by utilizing cellular, biochemical and molecular investigations of calcium-signaling pathways. Dr. Pessah has developed a strong, collaborative and

interdisciplinary research program with colleagues across the university, as well as nationally and internationally. He is director of The Center for Children's Environmental Health and Disease Prevention, and a member of the M.I.N.D. Institute. He is also a senior member of the NIEHS Center of Excellence in Toxicology and the Superfund Basic Research Program.

Glenn Rall
Associate Professor, Fox Chase Cancer Center; Program Leader of the Immune Cell Development and Host Defense program

Rall, an expert in viruses of the central nervous system, has been working in the virology and immunobiology laboratories at Fox Chase Cancer Center since 1995 where he investigates the causes and mechanisms of central nervous system diseases. In addition to his current work with the M.I.N.D Institute, he has also worked with The F.M. Kirby Foundation, investigating Lou Gehrig's Disease. He received his Ph.D. in 1990 from Vanderbilt University in Nashville and has authored many scientific publications as well as being the recipient of numerous awards and grants.

Lyn Redwood, R.N., M.S.N.
Executive Director, Coalition for SafeMinds

Ms. Lyn Redwood is co-founder and Executive Director of the Coalition for SafeMinds and co-founder of the National Autism Association. She became interested in autism research and advocacy when he son was diagnosed with Pervasive Developmental Disorder. Ms. Redwood testified before the Government Reform Committee on "Mercury in medicine: Are we taking unnecessary risks?" in 2000, and before a Congressional sub-committee on health in 2003. She has published in the journals *Neurotoxicology, Molecular Psychiatry, Expert Opin Pharmacother, Am. J Med Genet, Medical Hypotheses, Mothering Magazine,* and *Autism-Aspergers Digest*. Ms. Redwood has appeared on "Good Morning America," the Montel Williams Show, and has been interviewed by *U.S News and World Report, Wired Magazine, People* and numerous other publications. She is prominently featured in the award-winning book by David Kirby "Evidence of Harm." Ms. Redwood served on the **Department of Defense *Autism Spectrum Disorder Research Program*** from 2007-2009 and currently serves as a public member of the **National Institutes of Health *Interagency Autism Coordinating Committee***. She was also acknowledged for a decade of service by Spectrum Magazine as their person of the year in 2009.

Jason Richardson
Assistant Professor, Department of Environmental and Occupational Medicine at Robert Wood Johnson Medical School; Resident Member of the Environmental and Occupational Health Sciences Institute (EOHSI)

Jason Richardson, M.S., Ph.D. is an Assistant Professor at in the Department of Environmental and Occupational Medicine at Robert Wood Johnson Medical School and Resident Member of the Environmental and Occupational Health Sciences Institute (EOHSI). He received his M.S. and Ph.D.

degrees from Mississippi State University where he conducted research on mixtures of organophosphate pesticides and the developmental neurotoxicity of organophosphates during critical periods of development. He then completed postdoctoral training in Molecular Neuroscience and Neurotoxicology at Emory University where he focused on the role of pesticide exposure in Parkinson's disease. His research at EOHSI focuses on the role of environmental exposures during development and how such exposures interact with genetic susceptibility to produce neurological disease. Dr. Richardson has authored or co-authored 30 publications in the areas of developmental neurotoxicology, neurodegenerative disease, and pesticides. He has received the Outstanding New Environmental Scientist Award from the National Institute of Environmental Health Sciences and a Young Scientist Award from the American Society for Pharmacology and Experimental Therapeutics. Dr. Richardson is currently a member of the editorial boards of Toxicological Sciences and Neurotoxicology, and is an Associate Editor for BMC Neurology. He has served as a grant reviewer for several NIH panels, the Michael J. Fox Foundation for Parkinson's Disease Research, Autism Speaks, and the United Kingdom Parkinson's Disease Society.

Stephen Scherer
Director, McLaughlin Centre and Toronto Centre for Applied Genomics, Hospital for Sick Children and University of Toronto

Dr. Scherer holds the GlaxoSmithKline-CIHR Endowed Chair in Genetics and Genomics at The Hospital for Sick Children and University of Toronto. He has made numerous contributions to medical genetics including mapping sequencing and disease gene studies of human chromosome 7. He collaborated with the J. Craig Venter Institute to generate the first genome sequence of an individual ushering in an era of genomic medicine. In 2004, his team co-discovered global gene copy number variation (CNV) and has since shown that CNV is the most abundant type of variation of human DNA. His group has also discovered CNV to contribute to the etiology of autism and the *Database of Genomic Variants* he founded facilitates hundreds of thousands of diagnoses each year.

Dr. Scherer has won numerous honors including the 2004 Steacie Prize, an International Howard Hughes Medical Institute Scholarship, and the 2008 Premier Summit Award for Medical Research.

Caroline M. Tanner
Director of Clinical Research, Parkinson's Institute, Sunnyvale, California

Dr. Tanner completed a residency in Neurology and fellowship in Clinical Neuropharmacology and Movement Disorders at Rush University and a doctorate in Environmental Health Sciences at the University of California- Berkeley. Her clinical practice specializes in movement disorders, particularly Parkinson's disease (PD), atypical parkinsonism and dystonia. Her research interests include investigations of descriptive epidemiology, environmental and genetic determinants, biomarkers, early detection, nonmotor disease features and interventions for the secondary prevention, disease modification and symptomatic treatment of movement disorders and neurodegenerative diseases. Her current research includes epidemiologic investigations of PD, multiple system atrophy, dystonia, Huntington's disease, motor neuron disease, essential tremor and REM sleep behavior disorder in many

populations, including the NAS/NRC World War II Veterans Twins Registry, the Agricultural Health Study, the Honolulu Asian Aging Study, the Alaska Native Medical Center, the legally-mandated California PD registry pilot project, the international LRRK2 PD-GEM study, the Chinese National Consortium on Neurodegenerative Diseases, the Shanghai Parkinson's Study, and the Shanghai Textile Workers Study, as well as investigations of biomarkers in the PPMI and LABS-PD studies and clinical trials conducted by the Parkinson Study Group (PSG), the NINDS NET-PD, the Chinese Parkinson Study Group and industry sponsors.

Dr. Tanner chairs the Scientific Review Committee of the PSG and the Epidemiology Task Force of the Movement Disorders Society, co-chairs the NINDS PD Common Data Elements Committee, serves on the Committee on Sections of the American Academy of Neurology and the Executive Committee of the PSG and chairs several clinical trial data monitoring committees. She serves on the Scientific Advisory Boards of the Michael J. Fox Foundation and the National Spasmodic Dysphonia Association. Her honors include the Parkinson's Disease Foundation Outstanding Woman Researcher in 2004 and the University of California-Berkeley Alumni Association Award for Excellence in Achievement in 2008.

Raymond Tice
Chief, Biomolecular Screening Branch, National Institute of Environmental Health Sciences/National Toxicology Program

Dr. Tice received his Ph.D. in Biology in 1976 from Johns Hopkins University (Baltimore, MD). He was employed by the Medical Department at Brookhaven National Laboratory (Upton, NY) from 1976-1988, and by Integrated Laboratory Sciences, Inc. (Durham, NC) from 1988 to 2005, where his last position was Senior Vice-President for Research and Development. He joined the National Institute of Environmental Health Sciences (NIEHS) in 2005 as the Deputy Director of the National Toxicology Program (NTP) Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) and in 2009 became the Chief of the NTP Biomolecular Screening Branch. This Branch is responsible for coordinating the NTP High Throughput Screening (HTS) Initiative, the purpose of which is to identify and evaluate HTS assays that could be used to assess the ability of chemicals to perturb critical cellular pathways. This information could then be used to prioritize chemicals for further in-depth toxicological evaluation, identify mechanisms of action, and develop predictive models for *in vivo* biological response.

Dr. Tice has served as President of the Environmental Mutagen Society (EMS) and as Vice-President of the International Association of Environmental Mutagen Societies. He is the recipient of NIH Director's Group Awards for activities associated with the NIH Molecular Libraries Initiative and with the development of the ICCVAM Five-Year Plan (2008-2012). In late 2008, he (along with Dr. Christopher Austin of the NIH Chemical Genomics Center and Dr. Robert Kavlock of EPA's National Center for Computational Toxicology) received the North American Alternative Award from the Humane Society of the United States and Proctor & Gamble for "outstanding scientific contributions to the advancement of viable alternatives to animal testing". In 2009, Dr. Tice received the EMS Alexander Hollaender Award in recognition of outstanding contributions in the application of the principles and techniques of environmental mutagenesis to the protection of human health. During his career, he has served on over 50 international expert panels and committees related primarily to genetic toxicology and more recently to the validation of alternative test methods. He has published 130 scientific papers and book chapters, contributed to 23 electronic review publications in support of the NTP chemical nomination process and

to 35 NICEATM-ICCVAM publications, and has edited 4 symposia proceedings. Dr. Tice is a member of the editorial boards of Mutation Research and Environmental and Molecular Mutagenesis.